

Dust collecting technologies for blast furnace and steel melting shops

G.S.BASU*, R.P. SHARMA** AND A.S.DHILLON***

*Manager (Environment Mangement), TATA STEEL

** Divisional Manager (Environment Management), TATA STEEL

*** General Manager (Energy & Environment), TATA STEEL
Jamshedpur - 831 001, India.

ABSTRACT

The quality of environment at work place plays a dominant role in maintaining higher degree of plant availability, productivity, quality and the health of the employees. In an integrated iron and steel plant Blast Furnaces and Steel Melting Shops contribute to more than 70% of the dust pollution. This paper describes briefly the innovative technologies in use at Steel Plants to control pollution during Iron and Steel making processes. The technologies likely to dominate future scenario are also described briefly.

INTRODUCTION

The environmental conditions in the work area play an important role in the overall efficiency of work force. The control of environment helps a great deal in improvement of health and safety aspects at work place as well as in the enhanced production/productivity per capita. The steel plants, a decade or two ago were emitting thousands of tonnes of brown smoke and dust into the atmosphere affecting the health of men and machines. The situation is now changing fast and the technology adopted to arrest fumes and dust has helped in pollution control, resource conservation and in creating healthy work environment. In some of the developed countries the dust emissions have come down as much as 60-70% during 1970 to 1990. This paper briefly describes the changes brought in recent past on technology front to minimize dust emissions in Blast Furnaces and Steel Melting operations. The emphasis is laid on the use of cleaner technologies which help in energy and resource conservation, thereby protecting the environment in totality.

DUST POLLUTION-SOURCES

The dust pollution problems in an integrated iron & steel plant are mainly from primary and secondary emission sources. The tertiary sources contribute relatively less to the air pollution problems in steel plants.

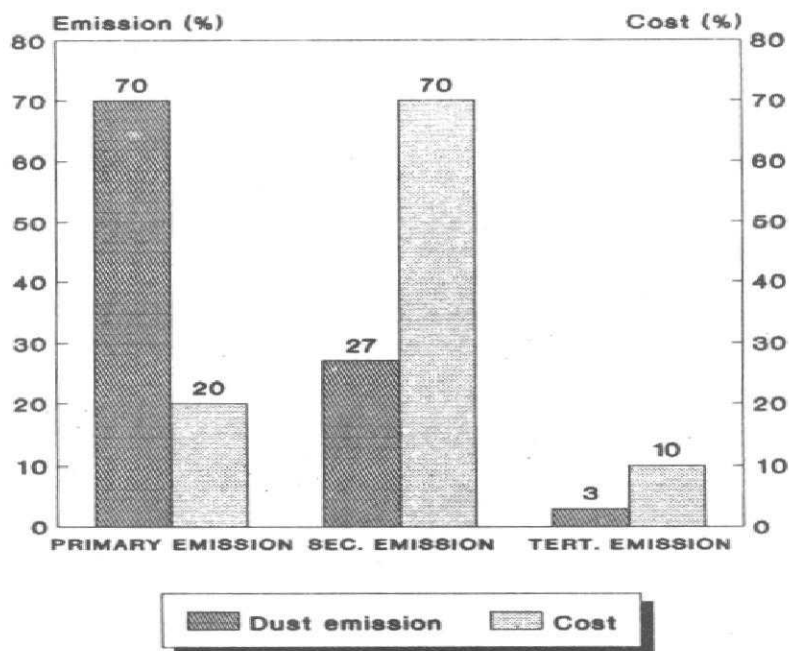
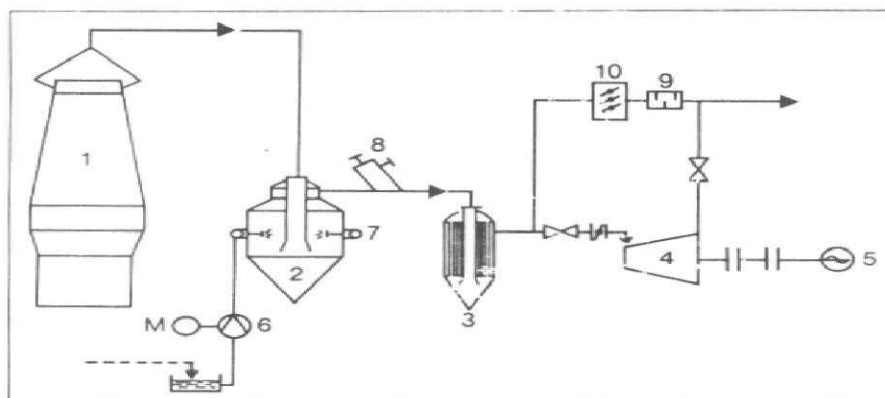


Fig.1 : Dust emission compared to investment costs



LEGEND:

- | | |
|------------------|------------------------|
| 1. Blast furnace | 6. High pressure pump |
| 2. Dust catcher | 7. Temperature control |
| 3. Bag filter | 8. Gas heating |
| 4. Gas turbine | 9. Silencer |
| 5. Generator | 10. Septum valve |

Fig.2 : Dry type blast furnace gas cleaning system

The primary emissions amount to 70% of total dust generated. These emissions take place from blast furnaces, LD converters, electric arc furnaces and flux calcination furnaces. The secondary emissions (27 to 28%) take place during iron and steel handling like tapping, pouring, coke oven pushings and desulfurisation activities. The raw material handling areas contribute to the tertiary emissions (2 to 3%).

In terms of the abatement cost, primary emission control systems cost approximately 20% while the secondary emission control devices (which handle at least 10 times more air) cost 70% of the total cost of abatement devices. The tertiary control systems are relatively less expensive as water suppression systems are extensively used for dust control in raw material handling areas. In places where dust suppression is not practiced, the system costs are relatively high. In general, the cost of abatement of tertiary emissions is about 10% of the total cost as shown in Fig.1 The primary emission controls have brought major changes in recent past in the environmental conditions specially in the control of brown fumes. The cleaning equipment used are normally wet scrubbers.

DUST COLLECTION SYSTEMS

Blast Furnaces

Primary Sources :Conventionally, the wet scrubbers had been used to clean blast furnace gases with or without top gas turbines for energy recovery. The temperature of the gas during cooling process is reduced to 50 °C thus losing a lot of sensible heat and hence poor energy recovery. The wet scrubbing process is uneconomical as the same requires water treatment, cooling towers and elaborate sludge handling facility. The process is highly energy intensive.

In recent past, dry cooling of gases has been introduced and tried out in some of the modern plants. The process involves conditioning of gases, dust catcher, bagfilters, gas turbine and power generator. The schematic diagram of the dry process gas cleaning system is given in Fig.2. The advantages offered by dry gas cleaning system over wet cleaning system are shown in Fig.3 and also described here below:

- o Energy recovery (Min 30% of sensible heat)
- o Low pressure drop in bagfilters compared to wet scrubbers, hence high energy efficiency
- o Less space requirement and less installation costs.
- o No operating cost for water treatment and sludge disposal/conditioning.
- o No make up water
- o Recycle/reuse of dust is much easier compared to wet sludge

In spite of several benefits mentioned above, dry process of gas cleaning is not yet established commercially on large scale. Most of the modern plants world over still continue to operate wet gas cleaning system in blast furnaces. The blast furnace gas

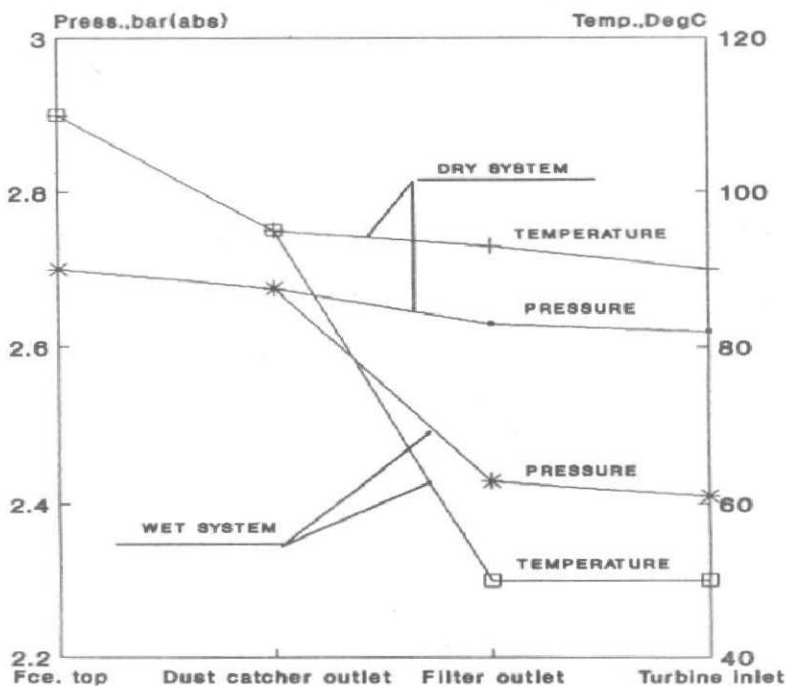


Fig.3 : Comparison of Wet and Dry-type gas cleaning system

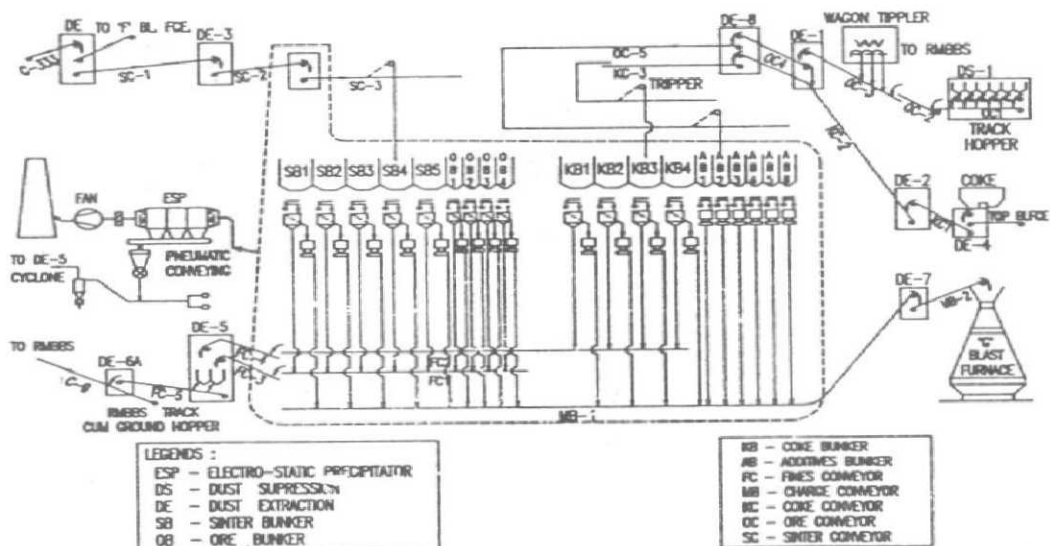


Fig.4 : Stock house dust control system of 'G' furnace at TATA STEEL

cleaning plants at Tata Steel are wet type. The gases from top of the furnace travel down the down comer to the dust catcher, where about 80% of the dust is removed. The gas from the dust catcher goes to the crude gas main from where it goes to the main gas cleaning plant. The process consists of three stages. In the first stage, the gas is washed by water in the washers. In the second stage, the gas is cleaned in the 'Lodge Cottrell' wet Electrostatic Precipitators. The gas is again led to tertiary precipitator for final cleaning to a dust content below 5 mg/Nm^3 . The dirty water from all the stages collected at the bottom is taken to thickeners for removal of sludge. The cleaned gas is used as fuel. In 'G' Blast Furnace, dry primary gas cleaning is done through dust catcher and cyclone in series. The wet secondary gas cleaning takes place in two stage Baumco Washers and the gas is cleaned to a dust content below 5 mg/Nm^3 . Dirty water is treated in clarifiers and cooling towers and recycled back to the washers.

The flue dust collected in the dust catchers and cyclones and the gas cleaning plant sludge are some of the main ferruginous solid wastes generated in the blast furnace operations. At Tata Steel, the flue dust is treated for magnetite recovery. A commercial scale plant is proposed to recover magnetite from flue dust to meet the entire requirement of magnetite at Jamadoba and West Bokaro coal washeries. The use of GCP sludge in domestic fuel as briquettes along with boiler ash is another avenue for waste utilisation developed at Tata Steel.

Secondary and Tertiary Sources : The secondary and tertiary emissions in blast furnaces have been successfully controlled by adopted state-of-art technologies for dust control in stock houses and cast houses. Fig.4 and Fig.5 show the details of the systems installed at 'G' Blast Furnace of Tata Steel for dust control in Stock House and Cast House respectively. Such type of systems have been adopted for the first time in Indian Steel Plants. The dust concentration at different locations of the Stock House with and without operation of the dust extraction system is shown in Fig.6 & 7. The results clearly indicate a commendable improvement in the work area environment of the stock house. The performance of the cast house dust/fume control system is given in Table-1 which shows much lower levels of the dust and other gaseous pollutants on the cast house floor compared to the statutory norms.

Table-1 : Pollution level of cast house floor at 'G' Blast Furnace with fume extraction system in operation

Location	Dust concentration (mg/m^3)	SO_2 ($\mu\text{g/m}^3$)	NO_x ($\mu\text{g/m}^3$)
Norm	10.0 (Total)	5000	6000
ESP side	1.3 - 3.5	5 - 15	50 - 75
Ramp side	0.9-1.3	10 - 38	30 - 50

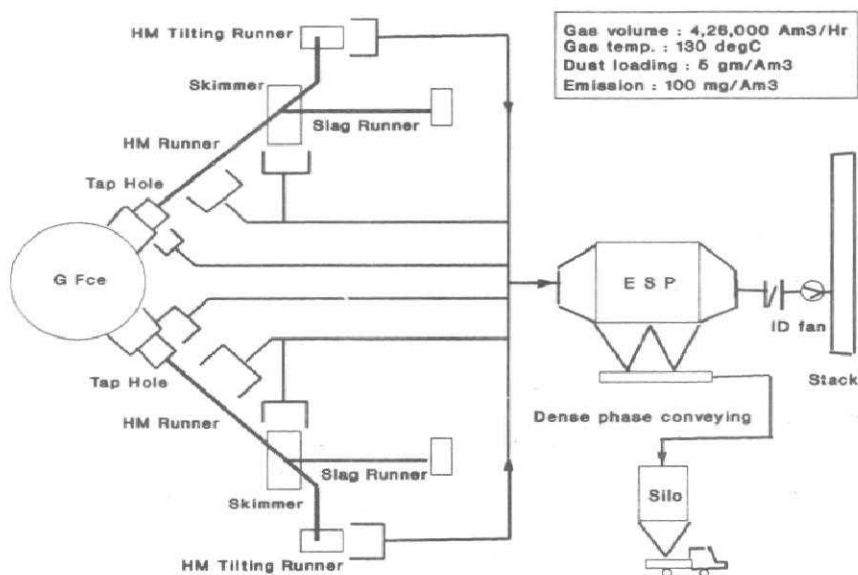


Fig.5 : Cast house fume extraction system of 'G' furnace at TATA STEEL

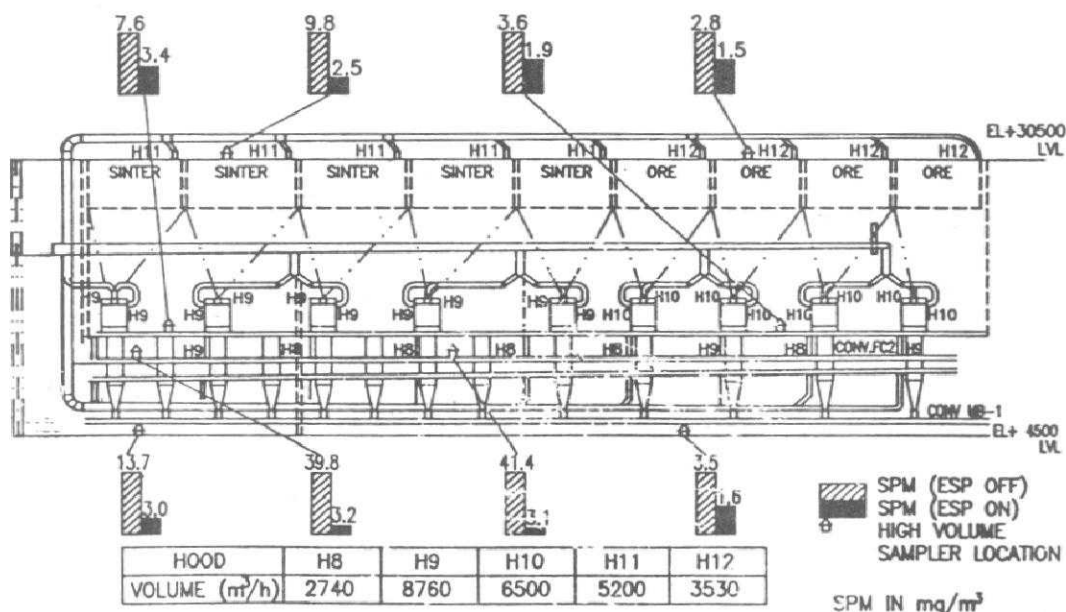


Fig.6: Dust concentration at stock house of 'G' furnace (Sinter & Iron Ore handling area)

LD Converters

Primary Sources :

LD converter gases contain 70-80% CO gas & leave the vessel at a temperature of 1600°C as primary emission. The calorific value of the gas is around 2000 KCal/Nm³. The flue gases contain vaporised iron, entrained slag, free lime and metallic particles. The cleaning of these gases therefore is necessary both from thermal as well as pollution angle. In the beginning and towards the end of heat cycle in a vessel, the CO levels in the gas are low. The gas having lean CO concentration is flared after cleaning. Higher percentage of CO in LD gases necessitates either combustion of gases before cleaning at the vessel mouth and/or in the primary collection hood or the recovery of the gases for use as fuel. The development of "Closed Type Hoods" in late 50's helped in effective recovery of gases for use as fuel. The combustion in such cases is limited only up to 10% of the theoretical air. At Tata Steel the gas cleaning and recovery systems comprise of :

- o Closed type hood resulting in the combustion of primary gas at vessel mouth with max 10% theoretical air (suppressed combustion process).
- o Radiation cooling up to 900-1000°C at hood outlet
- o Wet cleaning of gas in venturi scrubbers (2 stage) and ID fans
- o Clean gas handling through gas holders and/or flaring
- o Cleaning of gas in wet ESP for reuse (5 mg/Nm³ dust level)
- o Water treatment Plant
- o Sludge handling/drying facility for recycle to sinter plants or disposal as the case may be.

In suppressed combustion process, a pre-requisite is the control of air ingress into converter gases from atmosphere up to a maximum limit of 7 to 10%. The hood above the converter mouth is subjected to stresses by heat radiation as well as slag and metal projections from the furnace. The availability of the hood is, therefore, of vital importance. The schematic flow diagram of gas cleaning and recovery plant for LD/BOF converters installed at Tata steel is shown in Fig.8 and a typical heat balance for a converter is detailed in Fig.9. With this type of system the level of primary emissions from the LD shops have been completely controlled at Tata steel. The sludge generated from the gas cleaning plant is dewatered in the filters. Efforts are on to recycle the LD sludge in sinter making after drying the sludge using lime in a rotary dryer. Pilot scale trials at R&D are concluded and a commercial installation for recycle of LD sludge is on the anvil.

Secondary Sources

The dog houses are provided to control secondary emissions from furnace during charging/tapping/desulfurization operation. A typical secondary fume ex-

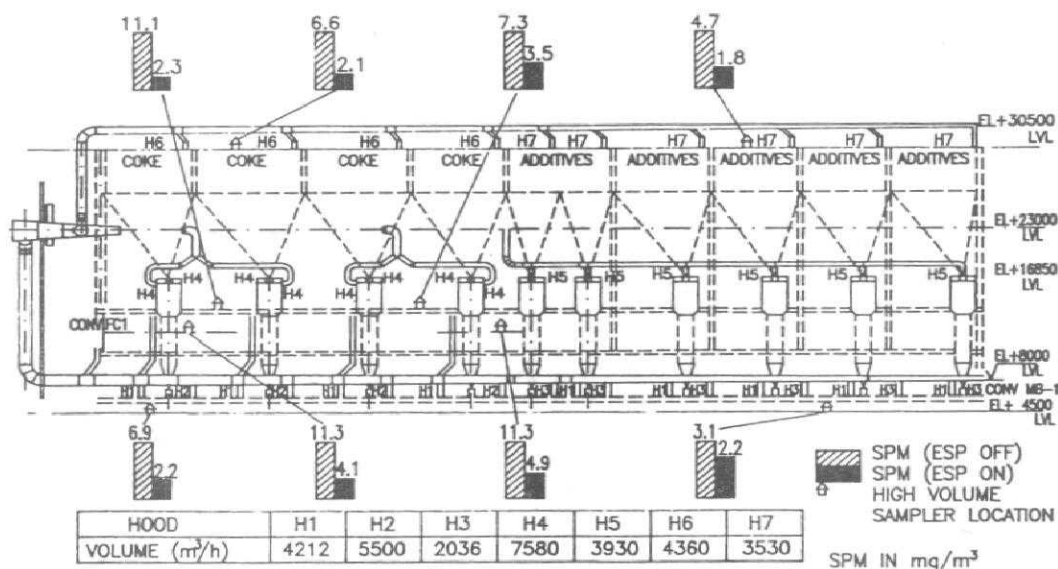


Fig.7: Dust concentration at stock house of 'G' furnace
(Coke and additive handling area)

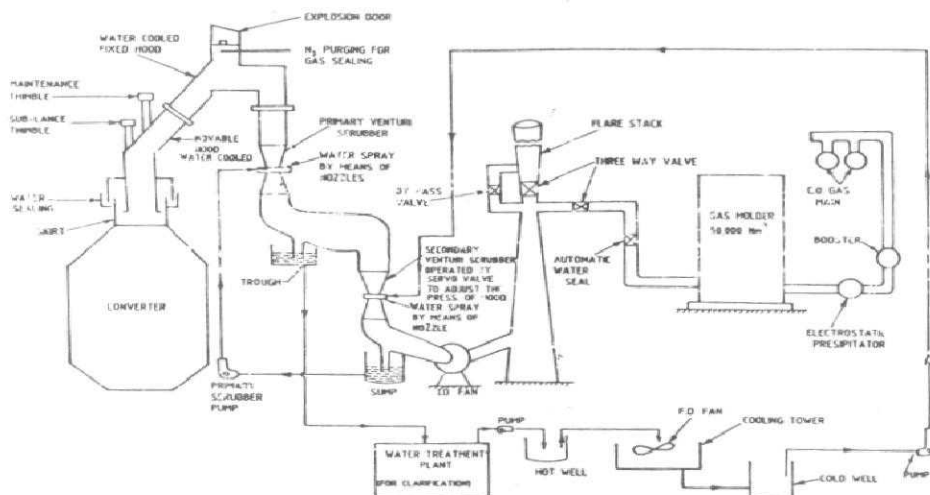


Fig.8: Gas cleaning and recovery plant for LD shop at TATA STEEL

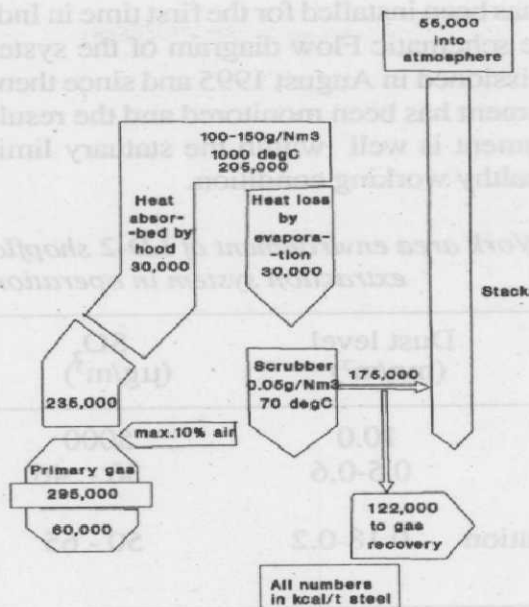


Fig.9 : Heat balance of a LD-Converter

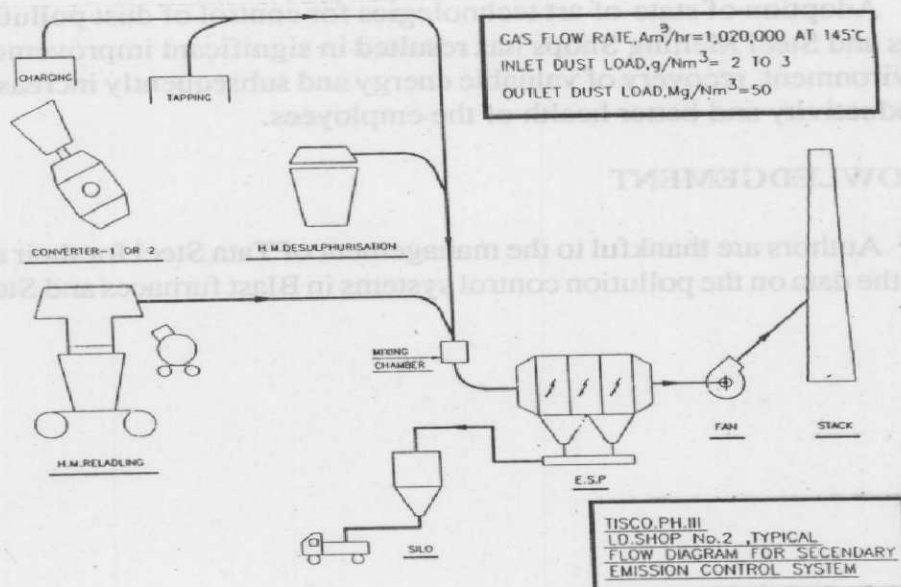


Fig.10 : Secondary fume extraction system of LD shop #2 at TATA STEEL

traction system for a 130 T converter vessel has a capacity of more than 1.0 million m³/hr. Such a system has been installed for the first time in Indian Steel Plant at LD-2 shop of Tata Steel. The schematic Flow diagram of the system is shown in Fig.10. The system was commissioned in August 1995 and since then working satisfactorily. The shop floor environment has been monitored and the results are given in Table-2. The work area environment is well within the statutory limits and the system provides comfortable and healthy working condition.

Table-2: Work area environment of LD-2 shopfloor with Sec. fume extraction system in operation

Location	Dust level (mg/m ³)	SO ₂ (μg/m ³)	NO _x (μg/m ³)
Norm	10.0	5000*	6000
Converter floor (9m level)	0.5-0.6	30 - 46	40 - 50
Near Desulphurisation unit	0.18-0.2	50 - 65	77 - 85

CONCLUSION

Adoption of state-of art technologies for control of dust pollution in blast furnaces and Steel Melting Shops has resulted in significant improvement in work area environment, recovery of valuable energy and subsequently increased production/productivity and better health of the employees.

ACKNOWLEDGEMENT

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